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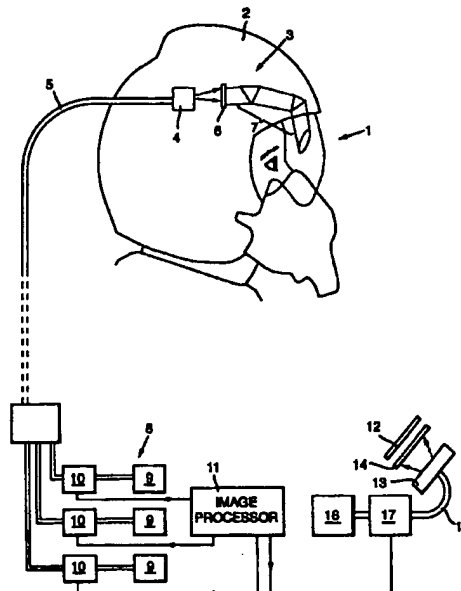
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(54) **Display Arrangements**

(57) A display arrangement particularly suitable for replacing a conventional CRT in a pilot's helmet mounted display includes a light source 8 having an output which is modulated at 10 and scanned by a scanner 4 across a screen 6 to produce an image. The image is transferred into the pilot's field of view by relay optics 7. The scanner 4 and screen 6 are mounted on the pilot's helmet 2 and the light source 8 is remote therefrom.



Description

[0001] This invention relates to display arrangements and more particularly, but not exclusively, to helmet-mounted displays used by aircraft pilots.

[0002] In a conventional helmet-mounted display, a small cathode ray tube (CRT) is mounted on the helmet of the pilot or other member of the air crew. The electron beam of the CRT is scanned over its faceplate to generate an image. Specially designed relay optics interface with the CRT faceplate to convey the image into the field of view of the pilot, typically being presented on a combiner attached to the helmet. The relay optics are generally quite complex, involving several elements for focussing and directing the image, and require a significant degree of design effort to integrate them with the CRT and with the part of the system which the pilot actually views. For example, if the image is to be projected onto a visor, the curvature of the visor, which may present a complex optical surface, must be taken into account. Electrical cabling connects the CRT to the power supply and also includes an electrical path for applying control signals to the CRT for scanning the electron beam and modulating it with the required information.

[0003] The present invention seeks to provide an improved display arrangement which is particularly suitable for use in helmet-mounted displays but which could also have application in other fields and in non-military environments.

[0004] According to the invention, there is provided a display arrangement comprising: a display device having a screen at which an image is produced and means for optically relaying an image from the device for viewing by a user, the display device comprising a light source, means for modulating light from the source with image information and a scanner for scanning modulated light over the screen, the screen and scanner being head mounted.

[0005] By employing the invention, it is possible to provide to a user an image of the same or superior quality as would be achieved with a CRT-based display arrangement and also provide a number of advantages. A CRT display is located close to the user's head and requires a high voltage supply. It also requires a relatively large and unwieldy umbilical cable to provide the electrical supply to the CRT. This leads to difficulties in adequately shielding the long run of cable to prevent electromagnetic interference effects. The size and weight of the umbilical may also inhibit the pilot's head movements and can be particularly problematical where the aircraft is expected to undergo manoeuvres involving high gravitational forces. Also, the designer must ensure that if a pilot is forced to eject from the aircraft, the umbilical will readily detach. In contrast, a display arrangement in accordance with the invention does not require a high voltage supply to produce an image on the screen. Preferably, the light source is remotely

located from the user's head and is connected to the scanner via fibre optic means. It may be sufficient to have only a single, mono-filament optical fibre connecting the light source and scanner. Thus, the potential danger of having a high voltage supply is avoided and the umbilical to supply the display arrangement is of considerably less weight than the HV supply of a conventional CRT arrangement, is less restrictive of head movement and easier to detach in the event of pilot ejection. Also, electromagnetic interference problems are greatly reduced. Any electrical supply to the light source can be much more easily shielded as it is compact and may be included in already existing shielding arrangements for other electrical systems in a cockpit.

[0006] Also, the head-mounted parts of a display arrangement in accordance with the invention can be made much lighter in weight than the CRT components and also occupy the same or a reduced volume as compared to a CRT. According to a particularly advantageous feature of the invention, a display apparatus includes an optical relay designed for use with a CRT and a display arrangement in accordance with the invention wherein the screen is located substantially in the position which would be occupied by a CRT faceplate if a CRT were included instead of the display arrangement. The display arrangement in accordance with the invention may be used as a straight replacement for the CRT of a previously designed and installed display arrangement. It is not therefore necessary to completely redesign the relay optics or other means for conveying the image to the user. Replacement may be carried out with very little disruption to the parts of the system already installed and the advantages which arise from using the invention may thus be incorporated into a previously existing, conventional arrangement with what is effectively a minor modification. The modification is also relatively inexpensive to implement as there is no significant redesign involved in installing it.

[0007] A further advantage arising from the invention is that the display may be a colour display although, of course, monochrome may be provided. In normal helmet-mounted displays using CRTs, monochrome only is available because the shadow mask required for colour cannot be accommodated in the small space available and also vibration can be a problem. Furthermore, a very bright display is required and this is difficult to achieve in small colour CRT displays.

[0008] In a display arrangement in accordance with the invention, the light source may be a single laser or a single LED (light emitting diode). Modulation of the light may be implemented by using a modulated light source, for example, a modulated LED or miniature laser diode or by modulating light subsequent to its generation. In other embodiments, a plurality of lasers or a plurality of LEDs may be included or it may be desirable, in some arrangements, to have a combination of the two types of light source. The plurality of lasers and/or LEDs may emit light of different wavelengths to give a colour dis-

play. The image produced for viewing by the user may include alphanumeric information, for example, data concerning an aircraft's altitude, heading and velocity or other information concerning aircraft systems or weapon status, in the case of military aircraft. Alternatively, or in addition, the image may be a pictorial display, for example, giving a representation of the view outside the cockpit as sensed, for example, by infrared imagers or image intensifiers. Alternatively, such pictorial information may comprise map data, for example.

[0009] The scanner may be arranged to direct the light beam using, for example, electromagnetic, electromechanical or acousto-optic means, for example. In the latter case, the scanner may be operable without requiring a direct electrical supply to be provided from the aircraft, control being by way of modulated light signals transmitted along an optical fibre link.

[0010] The screen of the display arrangements mounted on the helmet may, for example, be a plain glass plate or, for example, could be a dispersive hologram. In some embodiments the screen may comprise a phosphor faceplate. A laser beam, for example, an ultraviolet laser beam, may be scanned over the phosphor to produce a display.

[0011] According to a feature of the invention, an aircraft cockpit includes a plurality of displays, at least one of which is a display arrangement in accordance with the invention mounted on a helmet and at least one other of each is a head-down or head-up display comprising a light source, means for modulating light from the source with image information and a scanner for scanning modulated light over a screen. Thus, by using this aspect of the invention, it is possible not only to replace the conventional CRT display mounted on the pilot's helmet, but also at least one CRT found in other parts of the aircraft cockpit and preferably all of them include a similar display arrangement, thus eliminating CRT displays from the cockpit entirely, with the attendant advantages as discussed previously.

[0012] One way in which the invention may be performed is now described, by way of example, with reference to the accompanying drawing in which the sole figure schematically illustrates a display arrangement in accordance with the invention.

[0013] With reference to the figure, an aircraft pilot 1 wears a helmet 2 on which is mounted a display arrangement shown generally at 3 which is arranged to present an image to him on a visor or combiner.

[0014] The display arrangement 3 includes an acousto-optical scanner 4 for scanning a light beam transmitted to it via an optical fibre bundle 5 across a screen 6 which interfaces with relay optics 7 to transmit the image produced at the screen 6 into the pilot's field of view. The optical fibre bundle 5 is connected at its other end, remote from the helmet 2, to a light source 8 comprising a plurality of lasers 9 having outputs at respective different wavelengths and a plurality of modulators 10 associated with respective ones of the lasers 9.

[0015] An image processor 11 is connected to the modulators 10 to control the outputs of the light source 8, the light beams being combined following modulation and transmitted along the optical fibre 5 to the scanner 4. The scanner 4 causes the modulated light beam to be scanned across the diffusive screen 6 in a raster pattern to produce an image for viewing by the pilot 1.

[0016] The image may comprise alphanumerical information concerning the aircraft's flight, for example, or may consist of a pictorial display, for example, as may be obtained by an infrared camera mounted to view the scene ahead of the aircraft. A combination of the two types of image information may also be produced at the screen 6 and then conveyed via relay optics 7 for viewing by the pilot 1.

[0017] In this arrangement, the relay optics 7 were originally designed for use with a CRT display in which the faceplate of the CRT would have been located in the position now occupied by the screen 6.

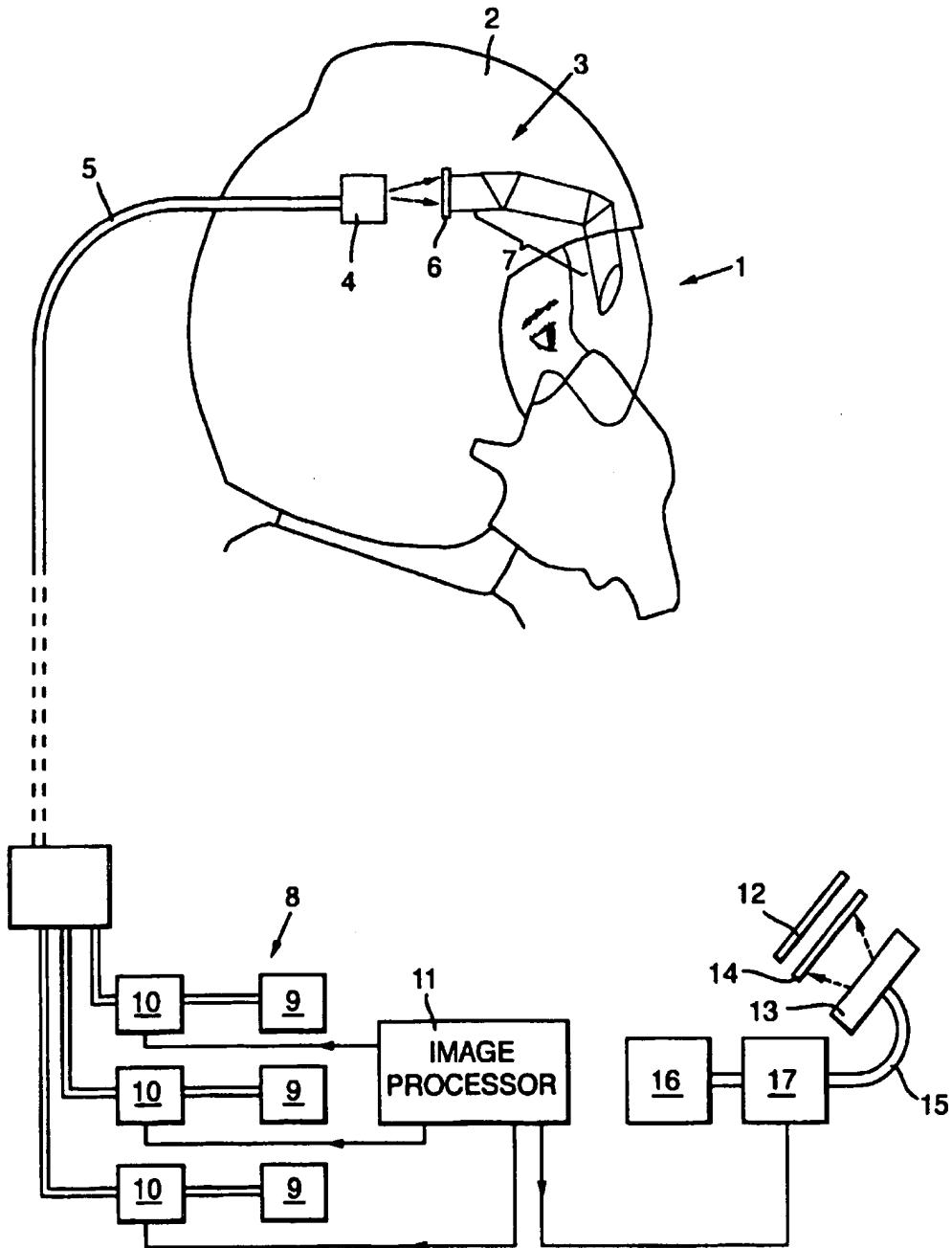
[0018] The pilot's cockpit includes an additional display 12 to be viewed as a head-down display. The head-down display 12 is also produced by scanning a modulated photon beam using a scanner 13 across a screen 14 to produce the desired image. An optical fibre 15 conveys modulated light from the light source 16 and modulator 17 which is also controlled by image processor 11 to produce the required image.

Claims

1. A display arrangement comprising: a display device having a screen at which an image is produced and means for optically relaying an image from the device for viewing by a user, the display device comprising a light source, means for modulating light from the source with image information and a scanner for scanning modulated light over the screen, the screen and scanner being head mounted.
2. An arrangement as claimed in claim 1 wherein the light source is remotely located from the user's head and is connected to the scanner via fibre optic means.
3. An arrangement as claimed in claim 1 or 2 wherein the light source comprises at least one laser.
4. An arrangement as claimed in claim 1, 2 or 3 wherein the light source includes at least one LED.
5. An arrangement as claimed in any preceding claim wherein the display device produces a colour image.
6. An arrangement as claimed in any preceding claim wherein the image includes alpha-numeric information.

7. An arrangement as claimed in any preceding claim wherein the image includes pictorial information.
8. An arrangement as claimed in any preceding claim wherein the screen comprises a dispersive hologram. 5
9. An arrangement as claimed in any one of claims 1 to 7 wherein the screen is of glass. 10
10. An arrangement as claimed in any preceding claim wherein the screen and scanner are mounted on a helmet worn by a user.
11. An arrangement as claimed in any preceding claim wherein the image is directed onto a combiner or visor for viewing by a user. 15
12. A display apparatus including an optical relay designed for use with a CRT and a display arrangement as claimed in any preceding claim wherein the screen is located substantially in the position which would be occupied by a CRT faceplate if a CRT were included instead of the display arrangement. 20 25
13. A display apparatus as claimed in claim 12 and adapted for use in an aircraft cockpit.
14. A display apparatus as claimed in claim 12 or 13 and including at least one additional display device comprising a light source, means for modulating light from the source with image information and a scanner for scanning modulated light over a screen. 30
15. An aircraft cockpit including a plurality of displays, at least one of which is a display arrangement comprising a display device having a screen at which an image is produced and an optical relay for optically relaying an image from said display device for viewing by a user, said display device comprising a light source, means for modulating light from said light source with image information and a scanner for scanning modulated light over said screen, said screen and scanner being mounted on a helmet; and at least one other of said plurality of displays being at least one of a head-down and head-up display and comprising a light source, means for modulating light from the source with image information and a scanner for scanning modulated light over a screen. 35 40 45 50

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EUROPEAN SEARCH REPORT

Application Number
EP 99 30 2611

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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 20 July 1999	Examiner Soulaire, D
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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